CLAIMS:

1. A bacteriochlorophyll derivative containing at least one, preferably two or three, negatively charged groups and/or acidic groups that are converted to negatively charged groups at the physiological pH, excluding pentacyclic bacteriochlorophyll derivatives having a free CH_2CH_2COOH or a $CH_2CH_2COO^-$ group at position 17, and tetracyclic bacteriochlorophyll derivatives devoid of a central metal atom and having a $-CH_2CH_2COOH$ group at position 17, a $-CH_2COOH$ or –COOH group at position 15, a -COOH group at position 13, methyl groups at the positions 2, 7, 12, 18, and ethyl groups at the positions 3 and 8.

2. A bacteriochlorophyll derivative according to claim 1 containing two negatively charged groups.

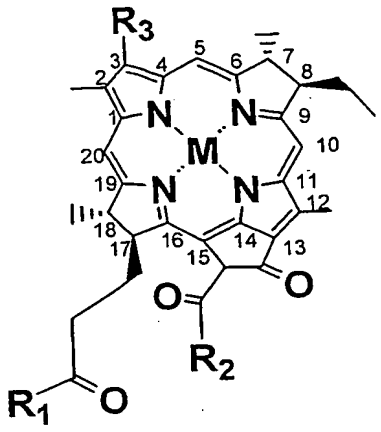
3. A bacteriochlorophyll derivative according to claim 1 containing three negatively charged groups.

4. A bacteriochlorophyll derivative according to any one of claims 1 to 3 wherein said negatively charged groups are selected from the group consisting of COO^-, COS^-, SO_3^-, and/or PO_3^{2-}.

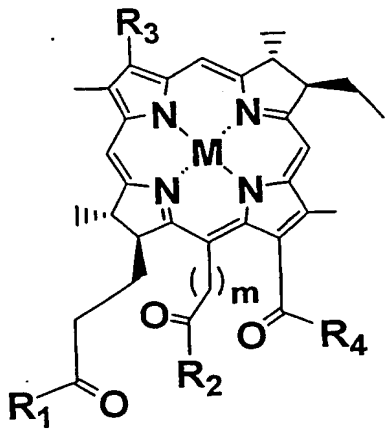
5. A bacteriochlorophyll derivative according to claim 1 wherein said acidic groups that are converted to negatively charged groups at the physiological pH are selected from the group consisting of COOH, COSH, SO_3H, and/or PO_3H_2.

6. A bacteriochlorophyll derivative according to any one of claims 1 to 5 derived from a natural or synthetic derivative of bacteriochlorophyll, including compounds in which the central Mg atom has been deleted or replaced by other metal atoms.

7. A bacteriochlorophyll derivative according to claim 1 of the formula I or II:



(I)



(II)

wherein

M represents 2H or a metal atom selected from divalent Pd, Pt, Co, Sn, Ni, Cu, Zn and Mn, and trivalent Fe, Mn and Cr;

R_1, R_2, and R_4 each independently is Y- R_5;

Y is O, S or NR_5R_6;

R_3 is selected from $-CH=CH_2$, $-C(=O)-CH_3$, $-C(=O)-H$, $-CH=NR_7$, $-C(CH_3)=NR_7$, $-CH_2-OR_7$, $-CH_2-SR_7$, $-CH_2-NR_7R'_7$, $-CH(CH_3)-OR_7$, $-CH(CH_3)-SR_7$, $-CH(CH_3)-NR_7R'_7$, $-CH(CH_3)Hal$, $-CH_2-Hal$, $-CH_2-R_7$, $-CH=CR_7R'_7$, $-C(CH_3)=CR_7R'_7$, $-CH=CR_7Hal$, $-C(CH_3)=CR_7Hal$, and $-C\equiv CR_7$;

R_5 , R_6 , R_7 and R'_7 each independently is H or selected from the group consisting of:

(a) C_1-C_{25} hydrocarbyl optionally containing one or more heteroatoms, carbocyclic or heterocyclic moieties, and/or optionally substituted by one or more functional groups selected from the group consisting of halogen, oxo, OH, SH, CHO, NH_2, $CONH_2$, a negatively charged group, and an acidic group that is converted to a negatively charged group at the physiological pH;

(b) a residue of an amino acid, a peptide or of a protein; and

(c) when Y is O or S, R_5 may further be R_8^+;

m is 0 or 1; and

R_8^+ is H^+ or a cation;

provided that:

(i) at least one, preferably two, of R_5, R_6, R_7 and R'_7 is a hydrocarbon chain as defined in (a) above substituted by a negatively charged group or by an acidic group that is converted to a negatively charged group at the physiological pH ; or

(ii) at least one, preferably two, of R_1, R_2, and R_4 is OH, SH, $O^-R_8^+$ or $S^-R_8^+$;or

(iii) at least one of R_1, R_2, and R_4 is OH, SH, $O^- R_8^+$ or $S^- R_8^+$ and at least one of R_5, R_6, R_7 and R'_7 is a hydrocarbon chain substituted by a negatively charged group or by an acidic group that is converted to a negatively charged group at the physiological pH; or

(iv) at least one of R_1, R_2, and R_4 is OH, SH, $O^- R_8^+$ or $S^- R_8^+$ and at least one of R_5, R_6, R_7 and R'_7 is a residue of an amino acid, a peptide or of a protein; or

(v) at least one of R_5, R_6, R_7 and R'_7 is a hydrocarbon chain substituted by a negatively charged group or by an acidic group that is converted to a negatively charged group at the physiological pH and at least one of R_5, R_6, R_7 and R'_7 is a residue of an amino acid, a peptide or of a protein;

but excluding the compounds of formula I wherein M is as defined, R_3 is -C(=O)CH_3, R_1 is OH or OR_8^+ and R_2 is -OCH_3, and the compound of formula II wherein M is 2H, R_3 is -C(=O)CH_3, R_1, R_2 and R_4 are OH, and m is 0 or 1.

8. A bacteriochlorophyll derivative of the formula I or II according to claim 7 wherein said negatively charged groups are selected from the group consisting of COO^-, COS^-, SO_3^-, and/or PO_3^{2-}.

9. A bacteriochlorophyll derivative of the formula I or II according to claim 7 wherein said acidic groups that are converted to negatively charged groups at the physiological pH are selected from the group consisting of COOH, COSH, SO_3H, and/or PO_3H_2.

10. A bacteriochlorophyll derivative of the formula I or II according to claim 7 wherein R_1 is Y- R_5 ; Y is O, S or NH; and R_5 is a hydrocarbon chain substituted by functional groups selected from OH, SH, SO_3H, NH_2, $CONH_2$, COOH, COSH, PO_3H_2.

11. A bacteriochlorophyll derivative of the formula I or II according to claim 7 wherein R_5 is the residue of an amino acid, a peptide or a protein.

12. A bacteriochlorophyll derivative of the formula I or II according to claim 1 containing a central Pd metal atom.

13. A bacteriochlorophyll derivative of the formula I according to claim 7 wherein:

M is Pd;

R_1 is $-NH-(CH_2)_n-SO_3^-R_8^+$, $-NH-(CH_2)_n-COO^-R_8^+$; $-NH-(CH_2)_n-PO_3^{2-}(R_8^+)_2$;

R_2 is methoxy;

R_3 is $-C(=O)-CH_3$;

R_8^+ is a monovalent cation such as K^+, Na^+, Li^+, NH_4^+; and

n is an integer from 1 to 10, preferably 2 or 3.

14. A bacteriochlorophyll derivative of the formula II according to claim 7 wherein:

M represents 2H, divalent Pd, Cu, or Zn or trivalent Mn;

R_1 is $-O^-R_8^+$, $-NH-(CH_2)_n-SO_3^-R_8^+$, $-NH-(CH_2)_n-COO^-R_8^+$; $-NH-(CH_2)_n-PO_3^{2-}(R_8^+)_2$; or Y-$R_5$ wherein Y is O, S or NH and R_5 is the residue of an amino acid, a peptide or a protein;

R_2 is C_1-C_6 alkoxy such as methoxy, ethoxy, propoxy, butoxy, more preferably methoxy;

R_3 is $-C(=O)-CH_3$, $-CH=N-(CH_2)_n-SO_3^-R_8^+$; $-CH=N-(CH_2)_n-COO^-{}_8^+$; $-CH=N-(CH_2)_n-PO_3^{2-}(R_8^+)_2$; $-CH_2-NH-(CH_2)_n-SO_3^-R_8^+$; $-NH-(CH_2)_n-COO^-R_8^+$; or $-NH-(CH_2)_n-PO_3^{2-}(R_8^+)_2$;

R_4 is $-NH-(CH_2)_n-SO_3^-R_8^+$; $-NH-(CH_2)_n-COO^-R_8^+$; $-NH-(CH_2)_n-PO_3^{2-}(R_8^+)_2$;

R_8^+ is a monovalent cation such as K^+, Na^+, Li^+, NH_4^+, more preferably K^+; and

m is 1, and n is an integer from 1 to 10, preferably 2 or 3.

15. A bacteriochlorophyll derivative of formula II in claim 7 wherein:

M is divalent Pd;

R_1 is $-O^- R_8^+$, $-NH-(CH_2)_n-SO_3^- R_8^+$, or Y-$R_5$ wherein Y is O, S or NH and R_5 is the residue of an amino acid, a peptide or a protein;

R_2 is C_1-C_6 alkoxy, preferably methoxy;

R_3 is $-C(=O)-CH_3$, $-CH=N-(CH_2)_n-SO_3^- R_8^+$; or $-CH_2-NH-(CH_2)_n-SO_3^- R_8^+$;

R_4 is $-NH-(CH_2)_n-SO_3^- R_8^+$; $NH-(CH_2)_n-COO^- R_8^+$; $NH-(CH_2)_n-PO_3^{2-} (R_8^+)_2$;

R_8^+ is a monovalent cation, preferably K^+;

m is 1, and n is 2 or 3.

16. A bacteriochlorophyll derivative of the formula I according to claim 13, consisting of the compound Palladium bacteriopheophorbide a 17^3-(3-sulfopropyl)amide potassium salt.

17. A bacteriochlorophyll derivative of the formula II according to claim 15, consisting of the compounds:

Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt;

3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt;

Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1,17^3-di(3-sulfopropyl)amide dipotassium salt;

Palladium 3^1-(3-sulfopropylimino)-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1,17^3-di(3-sulfopropyl)amide tripotassium salt;

Copper(II) 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt;

Zinc 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt;

Manganese(III) 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl)amide dipotassium salt;

Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide, 17^3-(N-immunoglobulin G) amide potassium salt;

Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-carboxy-ethyl)amide dipotassium salt;

Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(3-phosphopropyl)amide tripotassium salt; and

Palladium 3^1-(3-sulfopropylamino)-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1,17^3-di(3-sulfopropyl)amide tripotassium salt.

18. Palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt.

19. A pharmaceutical composition comprising a bacteriochlorophyll derivative according to any one of claims 1 to 18, and a pharmaceutically acceptable carrier.

20. The pharmaceutical composition according to claim 19 for photodynamic therapy.

21. The pharmaceutical composition according to claim 20 for vascular-targeting photodynamic therapy.

22. The pharmaceutical composition according to claim 20 or 21 for photodynamic therapy of tumors, including metastatic tumors.

23. The pharmaceutical composition according to claim 22 for photodynamic therapy of melanoma, colon, breast, lung, or prostate cancer.

24. The pharmaceutical composition according to claim 20 or 21 for photodynamic therapy of age-related macular degeneration.

25. The pharmaceutical composition according to claim 20 or 21 for photodynamic therapy of benign prostate hypertrophy.

26. The pharmaceutical composition according to claim 19 for tumor diagnosis.

27. A pharmaceutical composition according to claim 19 for killing cells or infectious agents comprising bacteria and viruses.

28. The pharmaceutical composition according to claim 27 for *in vitro* killing of cells or infectious agents comprising bacteria and viruses in a biological product upon illumination of said product.

29. The pharmaceutical composition according to claim 28 wherein said biological product is blood.

30. Use of a compound according to any one of claims 1 to 18 for the manufacture of a pharmaceutical composition for use in photodynamic therapy.

31. The use according to claim 30 for photodynamic therapy of tumors, including metastatic tumors.

32. The use according to claim 31 for photodynamic therapy of melanoma, colon, breast, lung, or prostate cancer.

33. The use according to claim 30 for photodynamic therapy of age-related macular degeneration.

34. Use of a compound according to any one of claims 1 to 18 for the manufacture of a pharmaceutical composition for diagnosis of tumors.

35. Use of a compound according to any one of claims 1 to 18 for the manufacture of a pharmaceutical composition for killing cells or infectious agents comprising bacteria and viruses.

36. A method for tumor photodynamic therapy which comprises:

(a) administering to an individual in need a compound according to any one of claims 1 to 18; and

(b) irradiating the local of the tumor.

37. A method for photodynamic therapy of age-related macular degeneration which comprises: (a) administering to an individual in need a compound according to any one of claims 1 to 18; and (b) irradiating the local of the macular degeneration.

38. A method for tumor diagnosis which comprises:

(a) administering to a subject suspected of having a tumor, a compound according to any one of claims 1 to 18; and

(b) irradiating the subject by standard procedures and measuring the fluorescence of the suspected area, wherein a higher fluorescence indicates tumor sites.

39. In a method for photodynamic therapy using a photosensitizer, the improvement wherein said photosensitizer is a bacteriochlorophyll derivative according to any one of claims 1 to 18.

40. In a method for diagnosis of tumors using a photosensitizer, the improvement wherein said photosensitizer is a bacteriochlorophyll derivative according to any one of claims 1 to 18.

41. In an in vitro method for killing of cells or infectious agents comprising bacteria and viruses, using a photosensitizer, the improvement wherein said photosensitizer is a bacteriochlorophyll derivative according to any one of claims 1 to 18.

42. The compound Palladium bacteriopheophorbide a 17^3–(3-sulfo-1-oxysuccinimide) ester sodium salt, as an intermediate.

43. A method for the preparation of compounds of formula II In claim 7 wherein R_1 is $-O^- R_8^+$; R_2 is $-OCH_3$; R_3 is acetyl; R_4 is a group $-NH-(CH_2)_n-SO_3^- R_8^+$; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) reacting the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with an aminosulfonic acid of the formula $H_2N-(CH_2)_n-SO_3H$ in a R_8^+-buffer; and

(ii) isolating the desired compound of formula II.

44. The method according to claim 43 for preparation of palladium 3^1-oxo-15-methoxycarbonylmethyl-rhodobacteriochlorin 13^1-(2-sulfoethyl) amide dipotassium salt which comprises: (i) reacting Pd-bacteriopheophorbide a with taurine of the formula H_2N-$(CH_2)_2$-SO_3H in a K^+ -buffer; and (ii) isolating the title compound.

45. A method for the preparation of compounds of formula II In claim 7 wherein R_1 is $-O^- R_8^+$; R_2 is $-OCH_3$; R_3 is acetyl; R_4 is a group $-NH-(CH_2)_n-COO^- R_8^+$; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) reacting the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with an aminocarboxylic acid of the formula $H_2N-(CH_2)_n-COOH$ in a R_8^+-buffer; and

(ii) isolating the desired compound of formula II.

46. A method for the preparation of compounds of formula II in claim 7 wherein R_1 is $-O^- R_8^+$; R_2 is $-OCH_3$; R_3 is acetyl ; R_4 is a group $-NH-(CH_2)_n-PO_3^{2-} (R_8^+)_2$; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) reacting the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with an aminophosphonic acid of the formula $H_2N-(CH_2)_n-PO_3H_2$ in a R_8-buffer; and

(ii) isolating the desired compound of formula II.

47. A method for the preparation of compounds of formula II in claim 7 wherein R_1 and R_4 contain the same negatively charged group, which comprises:

(i) reacting the corresponding M-bacteriopheophorbide with an excess of the aminosulfonic, aminocarboxylic or aminophosphonic acid in a R_8^+-buffer; and

(ii) isolating the desired 13,17-disubstituted derivative of formula II.

48. A method for the preparation of compounds of formula II in claim 7 wherein R_1 and R_4 are each a group $-NH-(CH_2)_n-SO_3^- R_8^+$; R_2 is $-OCH_3$; R_3 is acetyl; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) coupling the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with N-hydroxy-sulfosuccinimide (sulfo NHS)in the presence of 1-ethyl-3-(3-dimethylaminopropyl)-carbodiimide (EDC);

(ii) reacting the resulting M-bacteriopheophorbide-17^3-N-hydroxy-sulfosuccinimide ester with an excess of an aminosulfonic acid of the formula H_2N-$(CH_2)_n$-SO_3H in a R_8^+-buffer, thus obtaining a compound of formula I having a sole negatively charged group at position 17;

(iii) reacting the product of step (ii) with an excess of H_2N-$(CH_2)_n$-SO_3H in a R_8^+-buffer; and

(iv) isolating the desired compound of formula II.

49. A method for the preparation of compounds of formula II in claim 7 wherein R_1 and R_4 are each a group –NH-$(CH_2)_n$-$COO^-R_8^+$; R_2 is -OCH_3; R_3 is acetyl; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) coupling the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with N-hydroxy-sulfosuccinimide (sulfo NHS) in the presence of 1-ethyl-3-(3-dimethylaminopropyl)-carbodiimide (EDC);

(ii) reacting the resulting M-bacteriopheophorbide-17^3-N-hydroxy-sulfosuccinimide ester with an excess of an aminocarboxylic acid of the formula H_2N-$(CH_2)_n$-COOH in a R_8^+-buffer, thus obtaining a compound of formula I having a sole negatively charged group at position 17;

(iii) reacting the product of step (ii) with an excess of H_2N-$(CH_2)_n$-COOH in a R_8^+-buffer; and (iv) isolating the desired compound of formula II.

50. A method for the preparation of compounds of formula II in claim 7 wherein R_1 and R_4 are each a group –NH-$(CH_2)_n$-$PO_3^{2-}R_8^+$; R_2 is -OCH_3; R_3 is acetyl; R_8^+ is a monovalent cation; m is 1 and n is 1 to 10, which comprises:

(i) coupling the corresponding M-bacteriopheophorbide of formula I wherein R_1 is OH with N-hydroxy-sulfosuccinimide (sulfo NHS)in the presence of 1-ethyl-3-(3-dimethylaminopropyl)-carbodiimide (EDC);

(ii) reacting the resulting M-bacteriopheophorbide-17^3-N-hydroxy-sulfosuccinimide ester with an excess of an aminophosphonic acid of the formula H_2N-$(CH_2)_n$-PO_3H_2 in a R_8^+-buffer, thus obtaining a compound of formula I having a sole negatively charged group at position 17;

(iii) reacting the product of step (ii) with an excess of H_2N-$(CH_2)_n$- PO_3H_2 in a R_8^+-buffer; and (iv) isolating the desired compound of formula II.